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The detection of spiral arm modulation in the mass distribution of an optically flocculent galaxy

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Abstract. Spiral arm modulation in NGC 4062 (an optical flocculent) is detected for the first time; the Fourier spectra of NGC 4062 and NGC 5248 (a classic grand design in optical images) are almost identical.

Within the framework of the Density Wave Theory (Lin and Shu 1964) and the the modal theory of galactic spiral structure (Bertin et al. 1989) the *characteristic signature* of a two-armed grand design is the variation of amplitude with radial distance from the center, due to the interference of wave packets or modes which propagate inward and outward, being reflected off a central bulge.

Symmetric spiral arm amplitude modulations indicative of underlying wave modes have hitherto only been detected in the grand design galaxies M51, M81, M100 (Elmegreen et al. 1989) and in the multiple arm galaxy M101 (Elmegreen 1995). In all the cases, blue images (revealing the young Population I disk) were analysed. On the other hand, near-infrared images reveal the old stellar Population II disk component of spiral galaxies. The young Population I disk component may only constitute 5 percent of the dynamical mass of the disk of a galaxy. For studying mass distributions of disk galaxies, near-infrared images are essential (Block and Wainscoat 1991; Block and Puerari 1999).

We have applied a morphological method, based on the bidimensional Fourier transform[1], to detect the existence of structures with a different winding sense (trailing and leading patterns) in the same galaxy. The Fourier method was

[1]The bidimensional Fourier method has been extensively discussed in a number of papers, and the reader is referred to eg. Considère and Athanassoula (1982), Puerari and Dottori (1992), Puerari (1993), amongst others.

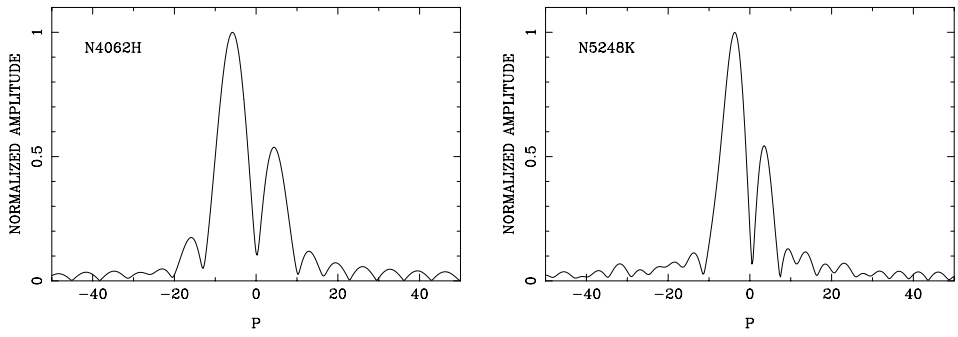

Figure 1. An optically flocculent (NGC 4062) and an optically 'extreme' grand design galaxy (NGC 5248) yield almost identical Fourier spectra in the near-infrared regime. Their mass distributions must be very similar, despite radically different optical morphologies. The m=2 Fourier component is illustrated in both cases.

applied to the near-infrared images of two galaxies which optically could not be more different: one is flocculent (NGC 4062) whereas the other (NGC 5248) is grand design. NGC 4062 displays a duality in spiral structure (see Block et al., this volume); its gaseous and stellar disks fully decouple.

In Figure 1, we show the bidimensional Fourier spectra for the bisymmetric m=2 component of both galaxies. Note the remarkable similarity between the spectra of both galaxies, despite the very different optical appearence of these galaxies (NGC4062 - optically flocculent; NGC5248: optically grand design). The consequence of two spiral patterns with *different winding sense* in the m=2 component directly implies spiral arm modulation.

A complete and detailed analysis of these galaxies was published in Puerari et al. 2000 (see also astro-ph/0005345).

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